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## Enhanced-xVSB System Development for Mobile/Portable Reception

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### Abstract

*This paper describes Enhanced-xVSB system for improving mobile/pedestrian reception performance to the ATSC DTV 8-VSB transmission standard. Proposed system is fully backward compatible with current ATSC 8-VSB standard. For mobile and portable reception support, E-xVSB system adopts a reduced constellation method as well as enhanced trellis-coded modulation scheme.*

### 1. INTRODUCTION

ATSC DTV system[1] does not perform well under dynamic ghost channel condition such as portable and mobile environments. To overcome this inferiority, We propose an Enhanced-xVSB system for improved ATSC standard. Enhanced-xVSB broadcast system will support flexible tradeoffs in payload data rate vs. performance in a 6-MHz channel. A functional diagram of the system is shown in Figure 1. The input to the system is a data stream comprising MPEG compatible packets. The system can transmit a mixture of the normal (8-VSB) stream and robust (enhanced) stream. All packets corresponding to the normal stream are sent using the existing 8-VSB scheme; these packets will be decoded by legacy receivers. All packets corresponding to the robust stream are sent using an enhanced coding scheme in a backward-compatible manner. Legacy receivers ignore the packets sent via the robust stream as these packets have a PID corresponding to a null packet. The modulation schemes for the robust packets are Pseudo 2-VSB, Enhanced 4-VSB, Enhanced 8-VSB and Hybrid-VSB. TOV for the robust stream is typically reached at a lower SNR compared to that of the normal VSB stream.[2]

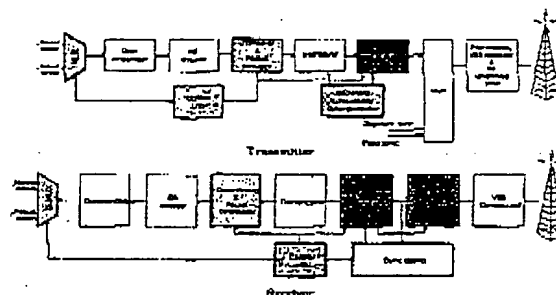


Figure 1. Block diagram of E-xVSB transmission/reception system

### 2. Performance of Enhanced-xVSB system

The ATSC normal stream uses 8-VSB modulation scheme. In this modulation scheme, the encoded data bits are mapped into 8-level(-7, -5, -3, -1, +1, +3, +5, +7) symbols. In standard receivers, DFE(Decision Feedback Equalizer) is usually used to compensate a multipath channel distortion. But in severe multipath channel condition, 8-VSB has performance limitation by distortion of input symbol constellation and increased probability errors, leading to error propagation in DFE. By using advanced equalizer slicer, reduced constellation(4-level VSB) and/or robust coding techniques(16-state TCM codec), E-xVSB receiver can be significantly improved on ghost handling performance as well as AWGN reception performance. These techniques can be also used to improve the reception of normal stream[3]. The proposed system is simulated under white noise and multipath environments to measure the TOV and to compare the different robust modes. Table I. shows the performance comparison of different robust modes under AWGN channel. It can be observed that

Pseudo-2VSB mode provides a gain of 1~4.5dB compared to Enhanced-8VSB mode [4].

Table 1. Performance comparison of the different robust modes

Robust mode	SNR@TOV(dB)
1/2 rate Pseudo-2VSB	6~6.5
1/2 rate ATSC E-VSB	7.5~8.0
1/4 rate Pseudo-2VSB	0.5~1
1/4 rate ATSC E-VSB	5.0~5.5

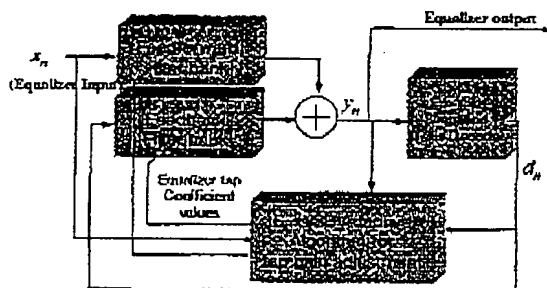


Figure 2. Advanced equalizer structure for E-xVSB receiver

Figure 2 shows a structure of DFE equalizer for E-xVSB receiver. A simplified trellis decoder can be used in E-xVSB receiver to provide a good estimate of transmitted symbol using reduced constellation and robust coding techniques. Figure 3. shows a equalizer convergence speed improvement by E-xVSB advanced equalizer technique[4]. Table 2. shows a dynamic multipath laboratory test results obtained by prototype receiver in 8-VSB and Pseudo-2VSB mode under -10dB, 10usec delay single echo channel. It is indicated that Pseudo-2VSB signal can significantly improve a dynamic ghost handling performance at receiver side.

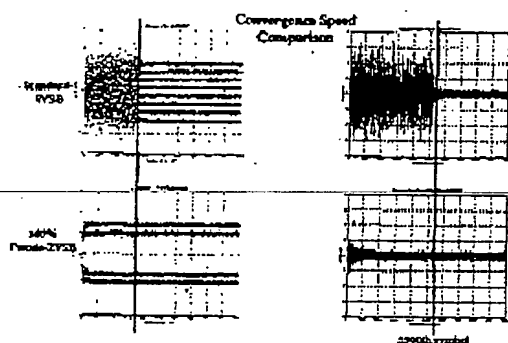


Figure 3. Equalizer convergence speed comparison between 8-VSB and E-xVSB/P-2VSB mode

Table 2. Susceptibility to single dynamic echoes

Stream Type	Robust stream mix ratio(%) mode	Doppler frequency before failure(Hz)
8-VSB	0	20
Pseudo-2VSB	100	370

This advantage of dynamic multipath performance can be used by broadcasters in a wide range of applications such as portable/mobile services.

## 5. Conclusion

Enhanced-xVSB system capable of transmitting a robust stream along with 8-VSB stream in a backward compatible manner using the ATSC 8-VSB system is presented. Performance results indicate that proposed E-xVSB system performs better than current ATSC E-VSB mode under AWGN channel as well as dynamic multipath channels. 1/2 rate mode provides a gain of 1~1.5dB, 1/4 rate mode provides a gain of 3~5dB compared to ATSC E-VSB mode. Enhanced-xVSB can provide a maximum service flexibility for broadcasters

## REFERENCES

- [1] Advanced Television System Committee, "ATSC Digital Television Standard, Doc. A/53," September 16 1995. <http://www.atsc.org>
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- [3] Vasanth R. Gaddam, Dagnachew Birru, "A Newly Proposed ATSC DTV System for Transmitting a Robust Bit-stream along with the Standard bit stream," IEEE Transaction on Consumer Electronics, Vol 49, No.4, November 2003.
- [4] Hyoung-Nam Kim, Sung-Ik Park, "Near-Optimum Blind Decision Feedback Equalization for ATSC Digital Television Receiver," ETRI Journal, Vol 26, pp.101-111, April 2004

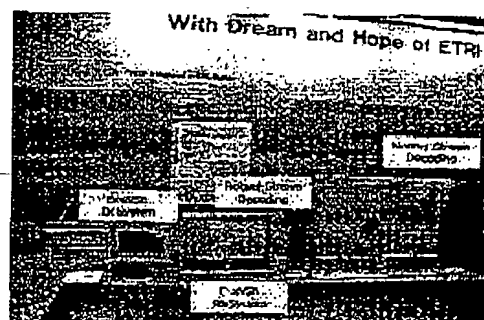


Figure 4. Enhance-xVSB Tx-Rx System Test Bed